Development of a Micro TPC Vertex Detector

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We are developing a new Micro TPC vertex detector that will be capable of tracking in the high track density environments which will be encountered in the STAR experiment at RHIC and in the ALICE experiment at LHC. This detector can handle track densities of 10 tracks/cm^2, approaching the capabilities of silicon devices.[1] It has, however, the important advantage that it is essentially massless in comparison. This greatly reduces problems due to multiple scattering and secondary interactions, which is of utmost importance for vertex detectors. This technology could provide a significant improvement over silicon in these experiments particularly at low pt where exciting results have been predicted for heavy ion collisions. In STAR the combined radiation length of the beam pipe plus silicon vertex detector averages 4.8%. Replacing the silicon detector with a Micro TPC will reduce the combined radiation length to 0.85%, an improvement factor of over 5.

The Micro TPC will use micro-strip gas chambers (MSGCs) to read out the signal. The fine pitch of these devices is well matched to the low diffusion that can be achieved with a short drift distance in dimethyl-ether (DME). This combination makes it possible to achieve much better two-track resolution than has been possible with other TPCs. The main thrusts of the program have been the demonstration that electrons can be drifted in DME over the planned drift distance of 15 cm without significant attenuation and the development of a MSGC system that can constructed with the required channel density. We have built a drift cell, shown in fig. 1, in which we measured electron attenuations of less than 0.1% loss per cm.[2] We have also produced a MSGC on a silicon amplifier chip and demonstrated suitable operation.

The MSGC was fabricated with the amplifier using a standard HP CMOS process. A postprocess layer of partially conductive Si-Carbide was added to correctly shape the electric field at the readout anode. Integrating the detector with the amplifier on a single chip reduces noise permitting low gas gain operation. We have successfully tested the detector-amplifier chip using an Fe^{55} X-ray source. The amplifier noise was 110 electrons rms which allowed excellent signal to noise operation with a gas gain of only 20.

Footnotes and References

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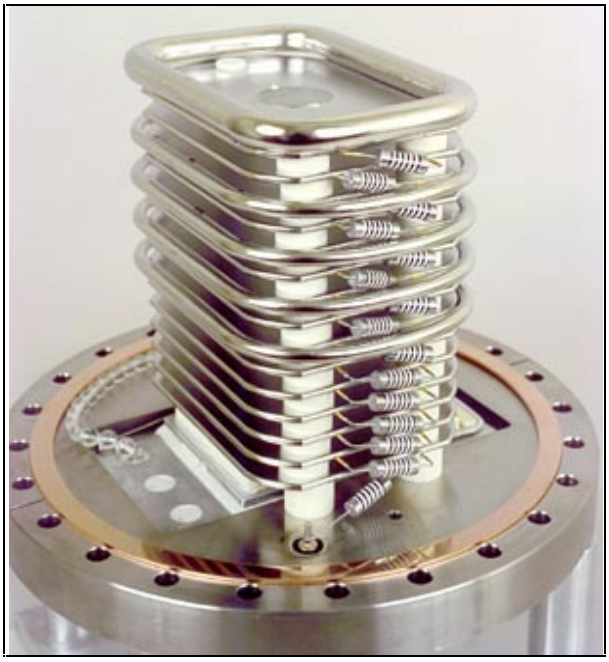

Fig. 1. Drift cell for testing electron attenuation while drifting through DME gas